

QUALITY ANALYSIS OF GERMAN TOBACCO CULTIVARS

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SUMMARY

Seventeen German cultivars were analysed according to nitrogen fertilization. New breeding lines as well as common types from cigar, Burley and Virgin types were investigated for smoke and leaf constituents: condensate, nicotine, CO, and NO in smoke; nitrate, alkaloids, sugar, and nitrogen in leaf. The limitation to 12 mg condensate per cigarette, asked by the EEC commission for 1995, can only be fulfilled with the lower stalk positions of the cultivars. Nicotine is changing according to the tobacco types. CO was found in a middle range equal for all types. NO changes according to the nitrogen fertilization and the cultivars. The leaf constituents nitrate, nicotine and the sum of nornicotine and myosmine correlate with cultivar, climate and fertilization.

INTRODUCTION

In 1995 the EEC commission demands the limitation of condensate to 12 mg per cigarette. Further on only tobaccos with a tar content beneath 12 mg per cigarette will be supported. Today most of the produced tobaccos do not fulfill this demand. Only the lower stalk positions of the cultivars show a tar content below 12 mg per cigarette. This is the case for German cultivars.

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Furthermore, the cultivation of tobacco in the EEC is restricted to regions with well defined cultivars and certain yields. The cultivars Virgin, Geudertheimer and Burley are only of interest for the German plantation. Seventeen German cultivars have been analyzed in leaf and smoke for: nitrate, alkaloides, condensate, nicotine, carbon monoxide and nitric oxide. In previous investigations the cultivar Virgin D showed a low rate of nitric oxide. Therefore no German Virgin cultivar has been analyzed. Six Geudertheimer cultivars, - lugs and leaf, N-fertilizer 180 kg/ha -, eleven Burley cultivars, - leaf and tips, N-fertilizer 180 kg/ha and the cultivar Badischer Burley E, - N-fertilizer variation 0 kg and 250 kg/ha have been investigated. All tobacco samples were unfermented. One thousand six hundred and twenty cigarettes, well defined in paper, filling power, and hardness were made by hand, under standardized conditions: twenty-seven samples, sixty cigarettes per sample. Nitric oxide has been determined separately in a second smoking procedure.

GEUDERTHEIMER CULTIVARS

Condensate, nicotine, carbon monoxide and nitric oxide. The Geudertheimer cultivars Geudertheimer III, Badischer Geudertheimer W, Badischer Geudertheimer K and Perega 234 were planted in 1987 in Forchheim. The stalk positions "lugs" and "leaf" were only air dried.

The EEC limitation to 15 mg condensate per cigarette is fulfilled for the cultivars Geudertheimer III and Badischer Geudertheimer W in the stalk position "lugs". In the stalk position "leaf" no Geudertheimer cultivar is within this limitation: all cultivars have values of 19 mg per cigarette and have therefore clearly 4 mg condensate more than 15 mg.

The nicotine level in the stalk position "lugs" of the Geudertheimer cultivars is very low. The stalk position "leaf" has with 0.19 mg nicotine per cigarette the lowest nicotine content. The tobacco year 1987 showed low temperatures combined with wet and rainy weather. Therefore the low nicotine content reflects more the weather conditions than the Geudertheimer properties: in dry and

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warm years the Geudertheimer cultivars produce rather high nicotine contents.

The carbon monoxide contents from 8 to 10 ml per cigarette in the Geudertheimer cultivars are very low. They are comparable with the contents of the commercial low carbon monoxide brands.

The Geudertheimer cultivars have surprisingly low nitric oxide contents: they are in the region from 67 to 88 ug (micrograms) per cigarette.

BURLEY - CULTIVARS

Condensate, nicotine, carbon monoxide and nitric oxide. In the year 1987 the cultivars Badischer Burley E, Bursanica 217, Pereko, B 535, Burley 21, G 37 and Burley CA were planted. The Maryland cultivar MD 609 was planted for comparison purposes.

All Burley cultivars have in the stalk "leaf" condensate values between nineteen and twenty milligrams per cigarette. They are clearly outside the EEC-limitation. Therefore the Burley cultivars have no chance of getting any promotion by the EEC-authorities, too.

The Burley cultivars show very low nicotine contents similar to the Geudertheimer cultivars. Bursanica 217, Pereco and B 535 have a nicotine content of 0.25 mg per cigarette, the cultivar Badischer Burley E of 0.93 mg per cigarette, the cultivar Burley CA of 0.99 mg per cigarette and the cultivar Burley 21 of 1.33 mg per cigarette.

The Burley cultivars show very low carbon monoxide contents. The amounts between 8.6 and 9.8 ml per cigarette are somewhat lower than the amounts of the Geudertheimer cultivars. The nitric oxide content in the smoke of Burley cultivars is low. It amounts from 84.8 ug to 211 ug per cigarette and is higher than those contents of nitric oxide ug found in Geudertheimer cultivars. The high content of 211 ug per cigarette is equal to the cultivars Badischer

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Burley E and only somewhat lower than that of the cultivar Maryland MD 609. This content equals to commercial brands with very high content of nitric oxide.

THE EFFECTS OF NITROGEN-FERTILIZER

For the Geudertheimer- and Burley-cultivars a N-fertilization of 180 kg. per hectare is recommended. The N-fertilization of more than of 180 kg. per hectare is a special experiment to show the effect of high N-fertilization in the smoke contents. In the case of zero fertilization the tobacco plant can only use the N-amount which is created by the mineralisation in the soil during the year. The harvesting grades of "leaf" and "tips" have been investigated in the tobacco leaf and smoke.

CONDENSATE

The condensate amounts of the Burley-tobacco with 250 kg N-fertilization per hectare is corresponding to those with 180 kg N per hectare. It has been found, that without N-fertilization the Burley-tobacco with 15.8 mg condensate per cigarette has already too much condensate according to the EEC demand. The Bad. Geudertheimer renders less condensate with 250 kg N per hectare (only 15.93 mg per cigarette). This amount seems to be false because the 180 kg N-fertilization creates already an amount of 19.31 mg per cigarette. In the Bad. Burley E ("tips") 20.6 mg condensate per cigarette are found with a fertilization of 250 kg N per hectare. In comparison to a zero fertilization the 250 kg N-fertilization makes the condensate content high, while in comparison with a 180 kg N-fertilization the condensate content is not so high. The cultivar Burlina 183, "tips", and the cultivar Burley NA, "leaf", - having 250 kg N-fertilization per hectare - are showing the same condensate amount of 20 mg per cigarette. The same has been observed in the cultivar Burling T89, "leaf", with a condensate content of 18.93 mg per cigarette and in the cultivar Burlina 183, "tips", with a condensate content of 20.23 mg per cigarette. Comparing the Burley-cultivars no differences are found with equal N-fertilization and within the same harvesting grade.

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NICOTINE

The cultivar Bad. Burley E, "leaf", having a N-fertilization of 250 kg per hectare, is creating a high nicotine amount of 4.8 mg nicotine per cigarette. Without N-fertilization a low content of 0.62 mg nicotine per cigarette has been found. In the cultivar Bad. Burley E, "tips", the content of 2.72 mg nicotine per cigarette has been found without N-fertilization and in the "leaf", with a N-fertilization of 250 kg. per hectare the same amount of nicotine as in the "tips" without N-fertilization. In this experiment it is documented that without N-fertilization low nicotine contents are found. The Burlina-cultivars with the special cultivar T89 have been found with high nicotine contents, the other special cultivar NA shows low to middle nicotine content with a N-fertilization of 250 kg per hectare. That is the reason why Burlina T89 is a high-level nicotine cultivar and the Burlina NA is a low-level cultivar. In the Burlina 183 cultivar a low to middle amount has been found. All Burlina-cultivars can be clearly differentiated according to their nicotine content.

CARBON MONOXIDE

Different N-fertilization is influencing the carbon monoxide content only slightly. A comparison between the N-fertilization of 250 kg N per hectare and no fertilization at all renders the same carbon monoxide content of 10.6 ml per cigarette. This content equals to the content of the cultivar Burlina 183 with a N-fertilization of 250 kg per hectare.

NITRIC OXIDE

The nitric oxide amounts are directly correlated to the N-fertilization. The variation without N-fertilization has been found in the cultivar Bad. Burley E, "leaf", with the lowest amount of 61.9 mg nitric oxide per cigarette, the variation with 250 kg N per hectare rendered 231 ug nitric oxide per cigarette. The sample with 180 kg N per hectare has been found with 211 ug per cigarette. The cultivar Burlina T89, "leaf", shows a very high content of 206 ug nitric oxide per cigarette with a N-fertilization of 250 per hectare. 180 kg N per hectare create a nitric oxide content of 94

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ug per cigarette in the cultivar Bursanica, "leaf". This amount equals to the low content of 93 ug nitric-oxide per cigarette of the cultivar Burlina 183, "tips", with 250 kg N-fertilization per hectare. The cultivar Burlina NA has been found with a slightly increased nitric oxide content of 140.9 ug per cigarette with a N-fertilization of 250 kg per hectare. The cultivar Bad. Geudertheimer is producing an amount of 170.4 ug nitric oxide per cigarette, with a N-fertilization of 250 kg per hectare, 180 kg N are producing only 67.8 ug nitric oxide per cigarette. All amounts are related to the "leaf". An exaggerated N-fertilization has been found to create the double nitric oxide content in the cultivar Bad. Geudertheimer. Very high nitric oxide amounts have been found in the cultivar Bad. Burley E, "tips", in the variation without N-fertilizer with 277.1 ug nitric oxide per cigarette and in the "leaf" with 250 kg N per hectare with 231 ug nitric oxide per cigarette.

NITRATE IN TOBACCO LEAF AND NITRIC OXIDE IN TOBACCO SMOKE

The components of the tobacco smoke are influenced by amount and composition of substances found in the tobacco leaf. In the cultivar Bad. Burley E with a N-fertilization of 250 kg. per hectare a nitrate amount of 1.2 % has been found, creating a nitric oxide amount of 231.6 ug per cigarette. Therefore it is now clearly seen, that the cultivar Bad. Geudertheimer creates a high nitric oxide content of 170.4 ug per cigarette with a N-fertilization of 250 kg per hectare and a nitrate content of 1.1 % in the leaf: the same nitrate content of 1.1 % nitrate is found in the leaf of the Bad. Burley E cultivar. This concentration is responsible for the nitric oxide content. The cultivars Burlina T89 and Burlina NA have been found to render a nitrate amount of 1.1 % or 0.9 % with a N-fertilization of 250 kg per hectare, which correlates to the high nitric oxide contents of 206.3 ug and 140.9 ug per cigarette.

NICOTINE AND NORNICOTINE IN THE TOBACCO LEAF

Independently of the cultivars low nicotine contents in the tobacco leaves have been found. Only the cultivar Burlina T89 has been found with a slightly higher content of 1.58 % nicotine compared to the cultivar Bad. Burley E with a content of 1.3 % nicotine and

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a N-fertilization of 250 kg per hectare. The cultivar Burlina NA is creating only 0.2 % nicotine together with a high nornicotine content of 1.2 %. The low amounts of the tobacco leaf components are directly correlated with the low amounts of the tobacco smoke contents. These low amounts are due to the tobacco year 1987, a cold and rainy year.

NITROGEN-FERTILIZATION AND NITRIC OXIDE AMOUNTS

A graphic plot of N-fertilization and nitrate contents in tobacco leaves and nitric oxide in tobacco smoke is showing the relationship between high nitrogen-fertilization and the extreme high nitric oxide amounts in tobacco smoke (graph No. 1). All Burley cultivars have been evaluated with the fertilizer concentration 0 kg N per hectare, 180 kg N per hectare and 250 kg N per hectare. The graph is showing clearly increasing rates of nitric oxide in tobacco smoke with an increasing nitrogen fertilization. Without N-fertilization the tobacco plant could only use the soil-nitrogen created during the vegetation period by mineralisation. The nitric oxide content starts at different levels according to the harvesting grades. The curve "leaf" goes from 60 ug NO per cigarette without N-fertilization to 250 mg NO with a N-fertilization of 250 kg per hectare (see graph No. 1, curve "leaf").

In the harvesting grade "tips" 120 ug NO per cigarette without N-fertilization are observed and 320 ug NO per cigarette with 250 kg N-fertilization per hectare (see graph No. 1, curve "tips"). Considering the results, the rates of N-fertilization are in good correspondence with the rates of nitric oxide. Appropriate to the harvesting grade there is a linear proportionality to be seen.

TOBACCO CULTIVARS AND NITRIC OXIDE

A summary of the oxide rates found shows that they usually range in accordance to N-fertilization of the cultivars. It has been found that the Geudertheimer cultivar with a N-fertilization of 180 kg per hectare has a very low nitric oxide range.

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TOBACCO BREEDING AND THE TASKS IN FUTURE

An excessive N-fertilization in tobacco cultivation used for an increase in yield is creating high levels of nitric oxide in tobacco smoke. This is shown by the German cultivar Bad. Burley E in the harvesting grade "leaf" and "tips". Altogether, the Burley cultivars are very high in nitric oxide content. An unexpectedly low nitric oxide content was found in the German Geudertheimer cultivars. Independently of fertilization and harvesting grades it has been found that the nitric oxide content is significantly correlated to the differences in the tobacco cultivars. Therefore the nitric oxide content has to be taken into consideration as a quality and breeding attribute for cultivars. The other compounds in tobacco smoke tar and carbon monoxide do not differ so much and have less variability according to parameters.

Graph 1

